

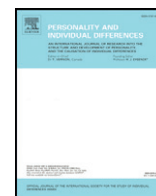


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# Wake up for the environment: An association between sleepiness and pro-environmental behavior



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## ABSTRACT

This study was designed to identify the relationships between sleepiness, pro-environmental behaviors and the balance between optimism and pessimism (O/P ratio). Two questionnaire surveys were conducted to collect data from randomly sampled residents in Japan ( $n = 382$  and  $n = 1200$ ), in order to compare behavioral and psychological factors as a function of sleepiness. Both surveys consistently indicated that respondents with low sleepiness were less pessimistic, and engaged in pro-environmental behaviors more frequently compared to those with high sleepiness, and that sleepiness is negatively associated with the O/P ratio and pro-environmental behaviors, implying that sleepiness might hinder pro-environmental behaviors in daily life. The association also implies that psychological factors such as sleepiness, optimism and pessimism are important for facilitating behaviors favorable to society.

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## 1. Introduction

Sleepy individuals tend to feel more anger, confusion, and fatigue and can become less enthusiastic about daily life activities (Kaida & Niki, 2014). This is because their sensitivity to positive life events becomes blunted, compared to individuals that are fully awake (Zohar, Tzischinsky, Epstein, & Lavie, 2005). As a result, sleepiness amplifies negative moods and attenuates positive ones, and influences human behavior through its effects on motivation (Dinges et al., 1997; Kaida & Niki, 2014; Zohar et al., 2005). It could therefore be expected that sleepy individuals would be reluctant to engage in activities, such as pro-social behaviors, which would optimally enhance their engagement with society. From this perspective, identifying psychological factors that influence pro-social behavior, including sleepiness, optimism, and pessimism, is becoming increasingly important in the fields of behavioral research such as behavioral economics and environmental psychology, because human behaviors are not only influenced by rational reasoning, but also by emotions and mood (Kahneman, 2011; Lindenberg & Steg, 2007).

Pro-social behavior refers to individual actions that are intended to improve social conditions and help other individuals (Eisenberg & Miller, 1987). It is known that engaging in pro-social behaviors can enhance mood, through positive feedback from performing 'good' actions (Penner, Dovidio, Piliavin, & Schroeder, 2005; Wallach & Wallach,

1983). Therefore, if the motivation for pro-social behaviors and engagements were to be hindered for some reason, people would be deprived of this type of positive mood enhancement.

Previous studies have identified associations between sleepiness and positive affect (Steptoe, O'Donnell, Marmot, & Wardle, 2008), suggesting that reducing sleepiness could be one approach to facilitating pro-social behaviors in everyday life. Sleepiness is a fundamental aspect of human existence that is known to influence everyday human behaviors. Nevertheless, surprisingly little is known about the relationship between sleepiness and pro-social behaviors, and therefore, we investigated this unique relationship.

Among various pro-social behaviors, pro-environmental behavior is a relatively new concept that is becoming increasingly important in the contemporary world that demands sustainable environmental management. Pro-environmental behaviors are generally defined as behaviors that reduce the environmental impact caused by human beings, and behaviors that improve environmental quality (Stern, 2000). They cover behaviors such as saving energy and reduced consumption of resources, the moderate use of motor vehicles, and nature conservation (Steg & Vlek, 2009). Although an individual's pro-environmental behavior might make only a minor impact on easing environmental pressures, society-wide and long-term accumulation of such behaviors can lead to major environmental impacts such as mass CO<sub>2</sub> emission reduction to ease global warming (Stern, 2000). In this study, we focused on the relationship between pro-environmental behaviors and sleepiness.

Managing psychological factors such as sleepiness and mood is important for facilitating pro-environmental behaviors, because it could maximize the impact of policies designed to promote such behaviors.

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It is known that engaging in pro-environmental behaviors make people feel more positive, and more satisfied, by allowing them to derive pleasure and satisfaction through contributing to society (Bolderdijk, Steg, Geller, Lehman, & Postmes, 2013; Steg, Perlaviciute, & van der Werff, 2015; Taufik, Bolderdijk, & Steg, 2015; Venhoeven, Bolderdijk, & Steg, 2013). Similarly, an optimistic way of thinking in an alert, less sleepy state might contribute to behaviors that are useful to society.

Previous surveys conducted in Sweden (Kaida & Kaida, 2016b) and Japan (Kaida & Kaida, 2016a) by the authors have indicated that pro-environmental behaviors, such as switching off lights, were positively related to subjective well-being, perhaps because it created positive feelings. Also, increased positive feelings caused by performing pro-environmental behaviors were related to individual dispositional traits, such as optimism and pessimism (Kaida & Kaida, 2016a). Thus, optimism and pessimism might play an important role in pro-social behaviors, including pro-environmental behaviors. An optimistic viewpoint seemingly allows people to generally maintain pro-environmental and pro-social behaviors. It is therefore important to understand sleepiness, optimism and pessimism, and pro-environmental behaviors and their associations to exert these relationships for promoting pro-social behaviors.

The present study was designed to investigate the relationships between sleepiness, optimism, pessimism, and pro-environmental behaviors as one domain of the pro-social behaviors. If sleepiness were associated with subjective affect, it could also be associated with pro-environmental behavior, and optimism and pessimism. The present study tested this hypothesis in two studies. The survey protocol of both studies were reviewed and approved by the Research Ethics Committee of the University of Tsukuba.

## 2. Study 1

In Study 1, we focused on switching lights off, which was defined as switching off lights when not in use, as a typical pro-environmental behavior conducted at home (Lanzini & Thøgersen, 2014). This behavior, which reduces energy consumption, is one of the easiest and most well-known ways of reducing CO<sub>2</sub> emissions at the individual level. We also focused on the level of sleepiness during daytime activities. The purpose of Study 1 was to confirm relationships among sleepiness, pro-environmental behavior, optimism, and pessimism.

## 3. Methods

### 3.1. Participants

In Study 1, we collected data using a questionnaire survey. Questionnaires were mailed to 1942 residents aged 20 years or older that were randomly sampled from the voter register in Tsukuba City, Ibaraki, Japan. Of these, 422 questionnaires were returned, and after omitting questionnaires with missing values, data of 382 (184 men) questionnaires were analyzed in the present study. None of the respondents had taken part in any previous investigations on sleepiness, or pro-environmental behaviors. Average age of participants was 48.5 years ( $SD = 12.6$ ), income was 5,625,600 yen; or USD 46,880 ( $SD = 2,691,200$  yen; or USD 22,420), and education level assessed by the percentage of people with university degrees indicated that 41.1% had degrees. Socio-demographic characteristics of the participants are shown in Table 1. The data used in the present study were collected as a part of an investigation on the effects of providing environmental information in facilitating pro-environmental behaviors.

### 3.2. Measures

#### 3.2.1. Subjective sleepiness scale

Two subjective sleepiness scales among others have been commonly used in sleep research, namely the Karolinska Sleepiness Scale (KSS;

**Table 1**  
Characteristics of respondents (Study 1).

	Mean or %	SD
Sex (% male)	48.17	
Age (years)	48.53	12.61
Education (% university degree)	41.10	
Income (household annual, yen)	5,625,654	2,691,226
Sleepiness (0–24)	9.23	4.26
Optimism (1–5)	3.16	0.58
Pessimism (1–5)	2.93	0.58
O/P ratio	1.14	0.43
PEB (1–6)	4.79	0.89

O/P ratio: optimism-pessimism ratio. PEB: pro-environmental behavior,  $n = 382$ .

Akerstedt & Gillberg, 1990) and the Epworth Sleepiness Scale (ESS; Johns, 1991), with the former assessing its transient and the latter the sleepiness in everyday situations. Subjective sleepiness in the present study was assessed using the ESS because we focused on the sleepiness in everyday situations and its association with other psychological factors and behaviors rather than instant sleepiness at certain times. The ESS is a widely used self-report scale that is used to measure the tendency to fall asleep in various situations during the daytime such as watching TV and sitting inactive in a public place. Respondents were asked to provide their evaluation of sleepiness in eight situations, by using a four-point Likert scale consisting of 0 (*would never doze*), 1 (*slight chance of dozing*), 2 (*moderate chance of dozing*), and 3 (*high chance of dozing*). Higher scores indicated greater subjective sleepiness. Cronbach's alpha of the scale in the present sample was 0.78.

#### 3.2.2. Optimism and pessimism

Optimism and pessimism were assessed using the Extended Life Orientation Test (ELOT; Chang, Maydeu-Olivares, & D'Zurilla, 1997), which consists of six items assessing optimism and nine items assessing pessimism. The 15 items comprising the ELOT were originally adopted from two different scales, the Life Orientation Test (Scheier & Carver, 1985) and the Optimism and Pessimism Scale (Dember, Martin, Hummer, Howe, & Melton, 1989), and include items such as 'In uncertain times, I usually expect the best', 'In general, things turn out all right in the end', 'Rarely do I expect good things to happen' and 'Things never work out the way I want them to'. Respondents were asked to rate their state of optimism and pessimism, based on the 15 ELOT items, by using a 5-point Likert scale anchored between 1 (*strongly disagree*) and 5 (*strongly agree*). Cronbach's alphas of the scale for the present sample were 0.70 for optimism and 0.82 for pessimism.

#### 3.2.3. Pro-environmental behavior

The question on pro-environmental behavior asked how often one performs actual behaviors, that is, 'I switch off room lights when not in use.' We assessed switching off lights, because it is a common, daily occurring, pro-environmental behavior that can be conducted at home, which has been investigated in several previous studies (Kaida & Kaida, 2016b; Steg & Vlek, 2009). Respondents were asked to rate their regular behavioral performance using a 6-point scale with a response scale anchored between 1 (*never*) and 6 (*always*).

### 3.3. Analysis

Respondents' behavioral and ELOT scores were divided into two groups based on their ESS scores. Johns (2000), and Doi and Minowa (2003) employed a summed ESS score threshold of 11 or higher, and 10 or lower to categorize their sample into a high daytime sleepiness group having an ESS scores of 11, or above, and a normal sleepiness group having a score of 10, or below (Doi & Minowa, 2003; Johns, 2000). The present study employed the same criterion to categorize respondents into low and high sleepiness groups. ELOT optimism and pessimism scores were parceled into analysis variables by averaging them

for each category. Moreover, the optimism-pessimism ratio (O/P ratio) was calculated by dividing the ELOT optimism score by the pessimism score to also examine the association of the balance of the two affects with sleepiness as well as that of each affect. Pro-environmental behavior scores were analyzed with no further processing. Score differences between the two sleepiness groups were tested using non-paired *t*-tests.

In addition to the analysis using *t*-test, we carried out the correlation analysis and calculated the correlation coefficients between the variables. All data preparation and analysis were conducted using Stata12.

#### 4. Results

The mean scores of each group are shown in Table 2. The mean age of the low sleepiness group was 4.9 years higher than that in the high sleepiness group ( $t(259) = 3.61, p < 0.001$ ). There was a tendency for income to be higher in the low sleepiness group than in the high sleepiness group ( $t(289) = 1.47, p = 0.071$ ). However, gender and education were not significantly different between the two groups (gender:  $t(281) = 0.42, p = 0.336$ , education:  $t(273) = 0.33, p = 0.372$ ).

Sleepiness was 3.6 points higher in the high sleepiness group compared to the low sleepiness group ( $t(271) = 25.33, p < 0.001$ ). Moreover, respondents in the low sleepiness group were significantly less pessimistic compared to those in the high sleepiness group ( $t(325) = 3.47, p < 0.001$ ). There was also a tendency for optimistic attitudes ( $t(294) = 1.27, p = 0.107$ ) to be higher in the low sleepiness group. Furthermore, the O/P ratio was significantly higher in the low sleepiness group than in the high sleepiness group ( $t(371) = 3.49, p < 0.001$ ). The O/P ratio was negatively correlated with sleepiness ( $r = -0.11, p < 0.001$ ). Additionally, pro-environmental behavior was significantly higher in the low sleepiness than in the high sleepiness group ( $t(254) = 1.85, p < 0.05$ ).

Consistent with the results of the dichotomized analysis presented above, the correlation analysis yielded significant positive correlations between sleepiness and pessimism ( $r = 0.13, p < 0.05$ ) and negative correlations between sleepiness and the O/P ratio ( $r = -0.11, p < 0.05$ ) and pro-environmental behavior ( $r = -0.10, p < 0.05$ ) as shown in Table 3. However, there was no significant correlation between sleepiness and optimism ( $r = -0.02, p = 0.639$ ).

#### 5. Discussion

In Study 1, we confirmed that individuals with low sleepiness were likely to be less pessimistic and involve in pro-environmental behaviors more often. The results suggest that the psychological factors such as sleepiness and O/P ratio are related to pro-environmental behaviors. Given this, in Study 2, we aimed to replicate the results from Study 1 and extend them to different types of pro-environmental behaviors.

#### 6. Study 2

In Study 2, different types of pro-environmental behaviors, including saving water, refraining from using motor vehicles, separating waste, as well as saving electricity were examined. It was considered that these behaviors were similar to the behavior of switching off lights analyzed in Study 1. Moreover, in Study 2, we assessed nocturnal sleep durations as well as sleepiness. We expected that pro-environmental behaviors would be better facilitated in less sleepy individuals than in sleepy individuals that have a shorter nocturnal sleep duration. We also expected that less sleepy individuals would be more optimistic than sleepy individuals.

#### 7. Method

##### 7.1. Respondents

In Study 2, data were collected on sleepiness, sleep duration, optimism, pessimism, and engagement in pro-environmental behaviors via an online questionnaire survey. Respondents were recruited through a commercial, Internet survey agency in Japan. Respondents were randomly sampled from among individuals that were pre-registered with the company and we collected data of 1200 adult Japanese residents aged 20 years or older (50.5% men). Similar to Study 1, none of the participants had taken part in any previous investigations on sleepiness, or on pro-environmental behaviors. Average age of respondents was 49.1 years ( $SD = 15.6$ ), income was 6,207,500 yen; or USD 51,729 ( $SD = 3,863,317$  yen; or USD 32,194) and education as assessed by the percentage of respondents with university degrees was 53.2%. Socio-demographic characteristics of the participants are shown in Table 4.

##### 7.2. Measures

In Study 1, we only inquired respondents about their subjective sleepiness, whereas in Study 2, we also inquired about their sleep duration at night. Similar to Study 1, respondents first rated their subjective sleepiness using the ESS, and then in Study 2, they were also asked to indicate their mean nocturnal sleep duration during the last one week in 10 min units. Moreover, data were collected on participants engagement in the following nine pro-environmental behaviors related to: shopping bags ('I bring a reusable bag for my daily grocery shopping'), water use ('I use water sparingly'), electricity use ('I use electricity sparingly'), reuse ('I purchase refillable products to allow reuse of plastic containers'), air conditioner temperature ('I set the air conditioner at a moderate temperature'), environmentally responsible products ('I purchase environmentally responsible products whenever they are available'), garbage separation at home ('I properly separate garbage at home') and garbage separation in public places ('I properly separate

**Table 2**

Difference of ELOT, socio-demographic characteristics and pro-environmental behavior for the high and low sleepiness groups (Study 1).

		ELOT			Pro-environmental behavior
		Optimism	Pessimism	O/P ratio	Switching off lights
Sleepiness	Low (n = 245)	3.18 (0.59)	2.86 (0.61)	1.20 (0.48)	4.85 (0.85)
	High (n = 137)	3.11 (0.56)	3.06 (0.50)	1.05 (0.31)	4.67 (0.96)
	<i>t</i>	1.25	3.47 **	3.49 **	1.85 *
Socio-demographic characteristics					
		% male	Age (years)	Education (years)	Income (household annual, yen)
Sleepiness	Low (n = 245)	49.00 (0.50)	50.29 (11.94)	13.98 (1.88)	5775,510 (2,719,581)
	High (n = 137)	46.80 (0.50)	45.39 (13.18)	13.91 (1.95)	5357,664 (2,628,288)
	<i>t</i>	0.42	3.61 **	0.33	1.47

Numbers in parentheses indicate standard deviations. \* $p < 0.05$ . \*\* $p < 0.01$ .

ELOT: the Extended Life Orientation Test. O/P ratio: optimism-pessimism ratio.

**Table 3**  
Pearson product-moment correlation coefficients between variables (Study 1).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Sleepiness	1.00								
(2) Optimism	−0.02	1.00							
(3) Pessimism	0.13*	−0.40**	1.00						
(4) O/P ratio	−0.11*	0.73**	−0.82**	1.00					
(5) PEB	−0.10*	0.03	−0.11*	0.04	1.00				
(6) Sex	−0.01	0.09	−0.07	0.08	−0.11*	1.00			
(7) Age	−0.23**	0.02	0.01	−0.03	−0.01	0.18**	1.00		
(8) Education	0.01	0.03	−0.22**	0.16**	0.10*	0.13*	−0.22**	1.00	
(9) Income	−0.05	0.11*	−0.25**	0.24**	0.05	0.10	−0.07	0.32**	1.00

O/P ratio: optimism-pessimism ratio. PEB: pro-environmental behavior. \* $p < 0.05$ , \*\* $p < 0.01$ .**Table 4**  
Characteristics of respondents (Study 2).

	Mean or %	SD
Sex (% male)	50.50	
Age (years)	49.09	15.62
Education (% university degree)	53.17	
Income (household annual yen)	6,207,500	3,863,317
Sleepiness (0–24)	9.64	5.38
Optimism (1–5)	3.16	0.78
Pessimism (1–5)	2.77	0.83
O/P ratio	1.34	0.81
Pro-environmental behavior (1–6)		
Bring a shopping bag	4.25	1.68
Use water sparingly	5.02	1.09
Use electricity sparingly	4.95	1.09
Reuse plastic containers	5.08	1.15
Moderate ear use	4.18	1.68
Moderate air conditioning temperature	4.54	1.33
Purchase environmentally responsible products	3.87	1.34
Separate garbage at home	5.22	1.10
Separate garbage in public places	5.10	1.12

O/P ratio: optimism-pessimism ratio.  $n = 1,200$ .

garbage in public places.’). Respondents were asked to rate their behaviors using a 6-point scale anchored between 1 (*never*) and 6 (*always*).

### 7.3. Analysis

Data were analyzed using the identical procedures as in Study 1, with the exception that in Study 2, the nine pro-environmental behaviors, as well as sleep time were examined.

## 8. Results

Mean ELOT scores, socio-demographic characteristics and pro-environmental behaviors for the sleepiness groups are shown in Table 5. Age of the low sleepiness group was 6.6 years older than that of the high sleepiness group ( $t(1059) = 7.35$ ,  $p < 0.001$ ). Income and education were not significantly different between the two groups (income:  $t(1016) = 0.52$ ,  $p = 0.302$ , education:  $t(1065) = 1.31$ ,  $p = 0.105$ ), whereas the ratio of men was higher in the high sleepiness group ( $t(1050) = 2.01$ ,  $p < 0.05$ ).

Sleepiness was 9.6 points higher in the high sleepiness group compared to the low sleepiness group ( $t(963) = 47.77$ ,  $p < 0.001$ ). Therefore, as expected, sleep duration at night was 16.7 min shorter in the high sleepiness group ( $t(1095) = 4.05$ ,  $p < 0.001$ ). Moreover, respondents in the low sleepiness group were significantly less pessimistic compared to those in the high sleepiness group ( $t(973) = 7.65$ ,  $p < 0.001$ ); however, there was no statistically significant difference in optimistic attitudes between the two groups ( $t(986) = 0.79$ ,  $p = 0.214$ ). Furthermore, the O/P ratio was significantly higher in the low sleepiness group than in the high sleepiness group ( $t(1143) = 4.38$ ,  $p < 0.001$ ). Additionally, six out of the nine pro-environmental behaviors examined in Study 2, that is, those related to ‘water’, ‘electricity’, ‘temperature’, ‘products’, ‘home garbage’, and ‘public garbage’ were conducted significantly more frequently by the low sleepiness group than by the high sleepiness group ( $ps < 0.041$ ). Also, there was a tendency for engagement in ‘reuse’ behaviors to be higher in the low sleepiness group than in the high sleepiness group ( $p = 0.104$ ). However, behaviors related to ‘shopping bags’ and ‘using motor vehicles’ were not significantly different between the two groups ( $ps > 0.170$ ).

The correlation coefficients show primarily identical tendency to those for Study 1, in which sleepiness is positively correlated with pessimism ( $r = 0.28$ ,  $p < 0.001$ ) and negatively with the O/P ratio ( $r = -0.15$ ,  $p < 0.001$ ) and some of the nine pro-environmental

**Table 5**  
Difference of ELOT, socio-demographic characteristics and pro-environmental behaviors for the high and low sleepiness groups (Study 2).

		ELOT			Sleep time (min)	%male	Age (years)	Education (years)	Income (household annual, yen)	
		Optimism	Pessimism	O/P ratio						
Sleepiness	Low (n = 711)	3.18 (0.75)	2.62 (0.77)	1.42 (0.85)	392.52 (73.10)	48.10 (0.50)	51.77 (15.39)	14.35 (1.86)	6,255,977 (3,789,424)	
	High (n = 489)	3.14 (0.82)	2.99 (0.86)	1.22 (0.73)	375.83 (68.05)	54.00 (0.50)	45.19 (15.14)	14.49 (1.32)	6,137,014 (3,971,161)	
	<i>t</i>	0.79	7.69 **	4.38 **	4.05 **	2.01*	7.35**	1.31	0.52	
		Pro-environmental behavior								
		Shopping bag	Water	Electricity	Reuse	Car	Temperature	Product	Garbage, home	Garbage, public
Sleepiness	Low (n = 711)	4.29 (1.72)	5.09 (1.09)	5.03 (1.07)	5.11 (1.15)	4.19 (1.65)	4.60 (1.32)	3.93 (1.31)	5.33 (1.04)	5.18 (1.10)
	High (n = 489)	4.20 (1.62)	4.92 (1.09)	4.95 (1.12)	5.03 (1.16)	4.16 (1.73)	4.46 (1.33)	3.78 (1.38)	5.06 (1.17)	4.99 (1.13)
	<i>t</i>	0.96	2.61 **	2.74 **	1.26	0.27	1.75 *	1.96 *	4.09 **	2.89 **

Numbers in parentheses indicate standard deviations. \* $p < 0.05$ , \*\* $p < 0.01$ .

ELOT: the Extended Life Orientation Test. O/P ratio: optimism-pessimism ratio.



behaviors ('shopping bag',  $r = -0.07, p < 0.05$ ; 'water use',  $r = -0.05, p = 0.070$ ; 'home garbage',  $r = -0.11, p < 0.001$ ; 'public garbage',  $r = -0.07, p < 0.05$ ) (Table 6).

## 9. Discussion

In Study 2, we replicated the results of Study 1 in which the sleepiness level is associated with the O/P ratio and pro-environmental behaviors. Furthermore, we identified that the reported sleep time was significantly shorter in the high sleepiness group than in the low sleepiness group. This implies that daytime subjective sleepiness could come from a shortage of sleep duration at night, although there is a possibility that any part of the reported sleepiness in the present population could be a result of insomnia or a sleep disturbance such as obstructive sleep apnea at night. Yet, generally speaking, their daytime sleepiness should be reduced if people sleep longer during the night. This suggests that extending sleep duration may be one of the easy and practicable approaches to reduce sleepiness and to facilitate pro-environmental behaviors. Reducing sleepiness may thus let people be prone to pro-environmental activities.

## 10. General discussion

The findings of this study indicated that sleepy individuals engaged in pro-environmental behaviors less often than less sleepy individuals. In Study 1, we found that switching off lights was less frequently performed by sleepy individuals. Moreover, in Study 2, we demonstrated an identical relationship between sleepiness and various pro-environmental behaviors that are performed in different daily life contexts. In addition, results of Studies 1 and 2 both indicated that less sleepy individuals were less pessimistic than sleepy individuals. These findings demonstrated that less sleepy people tend to engage in pro-environmental behaviors more frequently, and are more oriented to optimism as indicated by the O/P ratio though high/low sleepiness groups did not differ on the optimism measure in either Study 1 or 2. To the best of our knowledge, these relationships have never been reported before.

In both Studies 1 and 2, we assumed that less sleepy individuals are less pessimistic than sleepy people and optimism oriented (and less sleepy) individuals might predict the positive effects of their pro-environmental behaviors on the environment, whereas pessimistic individuals might not believe in the positive influence of their actions on easing environmental pressures. Based on this assumption, we hypothesized that sleepiness would be negatively related to pro-environmental behavior and the O/P ratio, which was supported by the present data. Therefore, reducing sleepiness could be an important approach to maintaining positive mental health conditions, by making people more optimism oriented and engaged in pro-environmental behaviors. This finding supports evidence for the positive association between health-related quality of life and pro-environmental behaviors that has been reported in a previous study (Yamazaki, Wakita, & Aoyagi-Usui, 2006). In addition to previous findings, the present study newly indicated that sleepiness is associated with the balance of optimism and pessimism (i.e., O/P ratio), as well as with pro-environmental behaviors in daily life. Therefore, less sleepiness could be more generally related to optimistic attitudes in life. An association between sleepiness and subjective well-being has been reported in previous studies (Birchler-Pedross et al., 2009; Steptoe et al., 2008).

A relationship between sleepiness and positive emotions has been previously reported. For example, Kaida and Niki (2014) suggested that sleepiness measured by using the Karolinska Sleepiness Scale (KSS) after total sleep deprivation was significantly and negatively associated with confidence ( $r = -0.55$ ), challenge ( $r = -0.38$ ), immersion ( $r = -0.52$ ) and vitality ( $r = -0.67$ ), which are constructs relevant to the flow experience (Kaida & Niki, 2014). The findings of this study corroborated these previous findings. Optimism and pessimism based on the O/P ratio were negatively correlated with sleepiness

**Table 6**  
Pearson product-moment correlation coefficients between variables (Study 2).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1) Sleepiness	1.00																	
(2) Sleep time	-0.14 **	1.00																
(3) Optimism	-0.03	0.14 **	1.00															
(4) Pessimism	0.28 **	-0.06	-0.55 **	1.00														
(5) O/P ratio	-0.15 **	0.09 **	0.74 **	-0.81 **	1.00													
(6) PEB, shopping bag	-0.07 *	0.04	0.17 **	-0.11 **	0.13 **	1.00												
(7) PEB, water	-0.05	0.08 **	0.19 **	-0.10 **	0.17 **	0.40 **	1.00											
(8) PEB, electricity	-0.04	0.07 **	0.15 **	-0.08 **	0.13 **	0.40 **	0.79 **	1.00										
(9) PEB, reuse	0.01	0.03 *	0.13 **	-0.04	0.11 **	0.33 **	0.48 **	0.47 **	1.00									
(10) PEB, car	-0.03	0.04	0.10 **	-0.03	0.06 *	0.28 **	0.30 **	0.28 **	0.23 **	1.00								
(11) PEB, temperature	-0.04	0.06 *	0.18 **	-0.11 **	0.16 **	0.36 **	0.46 **	0.50 **	0.38 **	0.37 **	1.00							
(12) PEB, product	-0.03	0.05	0.23 **	-0.08 **	0.15 **	0.35 **	0.35 **	0.38 **	0.31 **	0.29 **	0.50 **	1.00						
(13) PEB, garbage, home	-0.11 **	0.06 *	0.16 **	-0.15 **	0.18 **	0.34 **	0.44 **	0.44 **	0.40 **	0.24 **	0.35 **	0.34 **	1.00					
(14) PEB, garbage, public	-0.07 *	0.08 **	0.20 **	-0.13 **	0.18 **	0.35 **	0.42 **	0.43 **	0.41 **	0.25 **	0.38 **	0.34 **	0.80 **	1.00				
(15) Sex	-0.06 *	0.04	0.08 **	-0.08 **	0.09 **	0.29 **	0.11 **	0.13 **	0.10 **	0.13 **	0.17 **	0.16 **	0.13 **	0.17 **	1.00			
(16) Age	-0.21	0.10 **	0.07 *	-0.19 **	0.11 **	0.15 **	0.18 **	0.15 **	0.05 *	0.13 **	0.15 **	0.21 **	0.28 **	0.22 **	0.02	1.00		
(17) Education	0.03	-0.10 **	0.05	-0.07 **	0.06 *	-0.07 *	-0.05	-0.04	-0.03	0.03	-0.02	-0.05	-0.03	-0.05	0.22 **	-0.11 **	1.00	
(18) Income	-0.02	-0.11 **	0.16 **	-0.18 **	0.17 **	0.02	0.04	0.04	0.03	-0.08 **	-0.02	0.06 *	0.02	0.00	-0.10 **	-0.06 *	0.20 **	1.00

O/P ratio: optimism-pessimism ratio. PEB: pro-environmental behavior. \* $p < .05$ , \*\* $p < .01$ .

as assessed by the ESS in both Studies 1 and 2. KSS and ESS both assess subjective sleepiness, with the former evaluating its transient, and the latter the sleepiness in daily life. These results therefore suggest that the transient and daily aspects of sleepiness both have a negative impact on the balance of optimism and pessimism, and environmental attitudes.

Ample evidence indicates that optimistic individuals, compared to pessimistic individuals, take an adaptive view in the face of difficulties to regulate themselves and their personal state using effective coping strategies to pursue valued goals (Carver, Scheier, & Segerstrom, 2010). In addition, optimistic individuals have sufficient confidence to achieve their goals and they tend to be persistent, even when progress toward their goals is difficult, or slow. As a result, optimistic individuals are good at coping with difficulties, which is also related to psychological adjustment to the society in which they live (Carver et al., 2010). This leads optimists to be less susceptible to depression and enable them to enjoy higher levels of psychological well-being (Given et al., 1993). In addition, the low sleepiness group was less pessimistic and more optimism oriented as indicated by the O/P ratio, compared to the high sleepiness group. These results imply that sleepiness might be a factor in optimistic orientations that could eventually influence pro-environmental behaviors.

The findings of the present study are constrained by certain notable limitations. Firstly, the surveys were cross sectional studies with relatively small samples. Therefore, we could not identify or propose any causal relationships between sleepiness, optimism and pessimism, and pro-environmental behaviors. Also, the low return rate (i.e., 17%) in the mail questionnaire survey in Study 1 may limit the significance of the present study for generalizing the findings. Secondly, objective measures of pro-environmental behavior and sleep quantity and quality were not used in the present study. Objective measures including observed or recorded frequencies of pro-environmental behaviors, as well as objective sleep/wake activity patterns measured by actigraphy might more accurately elucidate relationships between pro-environmental behavior and sleepiness. Moreover, it is suggested that further studies designed to identify potential causal relationships among these factors should be conducted in the future.

In conclusion, this study is the first to identify an association between sleepiness and pro-environmental behaviors, despite its limitations. The findings of this study imply that psychological factors such as sleepiness, optimism and pessimism are important for facilitating behaviors beneficial to society, including pro-environmental behaviors. Appropriate management of sleepiness could increase more optimistic people, which in turn would facilitate increased pro-environmental behaviors.

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